HWG | HARRIS, WILTSHIRE & GRANNIS LLP

June 28, 2017

Ex Parte

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band, ET Docket No. 13-49

Dear Ms. Dortch,

On June 26, 2017, Danielle Piñeres and Andy Scott of NCTA – The Internet & Television Association; Bruce Kostreski, a consultant for NCTA; and Austin Bonner and I, both of Harris, Wiltshire & Grannis LLP, met with Julius Knapp, Matthew Hussey, Jamison Prime, Karen Rackley, Brian Butler, Martin Doczkat, Geraldine Matise, Ira Keltz, and William Hurst, all of the Office of Engineering and Technology. Walter Johnston, Rashmi Doshi, Steve Jones, Howard Griboff, and Dusmantha Tennakoon, all of OET, and Rob Alderfer and Joey Padden of CableLabs, participated by phone.

During the meeting, we discussed CableLabs' testing and risk informed assessment of adjacent-channel interference impact to DSRC from Wi-Fi operations under the rechannelization proposal. As described in the attached presentation, measurement and risk-informed interference assessment demonstrate that Wi-Fi operations in lower-frequency U-NII-4 channels would not undermine adjacent-channel DSRC operations in the exclusive safety band created by rechannelization.

In response to a question received during the meeting, NCTA here provides information regarding the information elements and fields contained within existing DSRC standards that can be used to distinguish Basic Safety Messages ("BSMs") from other DSRC transmissions: SAE J2945 § 6.3 (mandates the contents of BSMs); SAE J2945 § 6.3.4 (specifically identifies EDCA access category mappings based on critical event flags); SAE J2945 § 3.1.2 (enumerates the critical event flag types, which specifically mark safety event related BSMs differently from generic periodic BSMs); and SAE J2735 §5.2 (defines Part 1 data, included in all BSMs, differently from Part 2 data optionally included in BSMs for specific purposes). Apart from these standardized BSM identifying elements, software solutions could alternatively use implementation specific methods for distinguishing BSM from non-BSM frames within its stack.

* * *

Pursuant to the FCC's rules, I have filed a copy of this notice electronically in the above-referenced proceeding. If you require any additional information, please contact the undersigned.

Sincerely,

Paul Margie
Counsel for NCTA – The Internet & Television Association

cc: Meeting participants

Tests Confirm That 5.9 GHz Rechannelization Protects Adjacent-Channel DSRC Safety Operations

ncta

THE INTERNET & TELEVISION ASSOCIATION

CableLabs®

Rechannelization protects DSRC safety operations

- Rechannelization is the most effective way to protect safety-critical, latency-sensitive DSRC operations.
- This approach reserves channels exclusively for safety use so there is no co-channel interference with these safety-of-life services.
- Measurement and risk-informed interference assessment demonstrate that Wi-Fi operations in lower frequency channels also would not undermine adjacent-channel DSRC operations in the exclusive safety band.
  - Test results are clear and consistent: across a variety of scenarios, the impact of adjacent-channel Wi-Fi on DSRC is miniscule.
  - Risk-informed interference assessment with conservative assumptions shows that there is only a **0.002% probability** that Wi-Fi operations would cause adjacent-channel DSRC packet error rates (PER) to reach 10%.
  - This is thousands of times less impactful to DSRC operation than the limitations of GPS availability.

Key findings

- Rechannelization provides excellent protection to DSRC safety transmissions.

- CableLabs tested a range of coexistence parameters and analyzed different scenarios (spectral separation, power levels, Wi-Fi duty cycles, and DSRC use cases) to determine the probability of DSRC PER exceeding 10%.

- Across these test results and scenarios, the maximum probability of DSRC PER exceeding 10% due to adjacent-channel Wi-Fi was only **0.002%.**

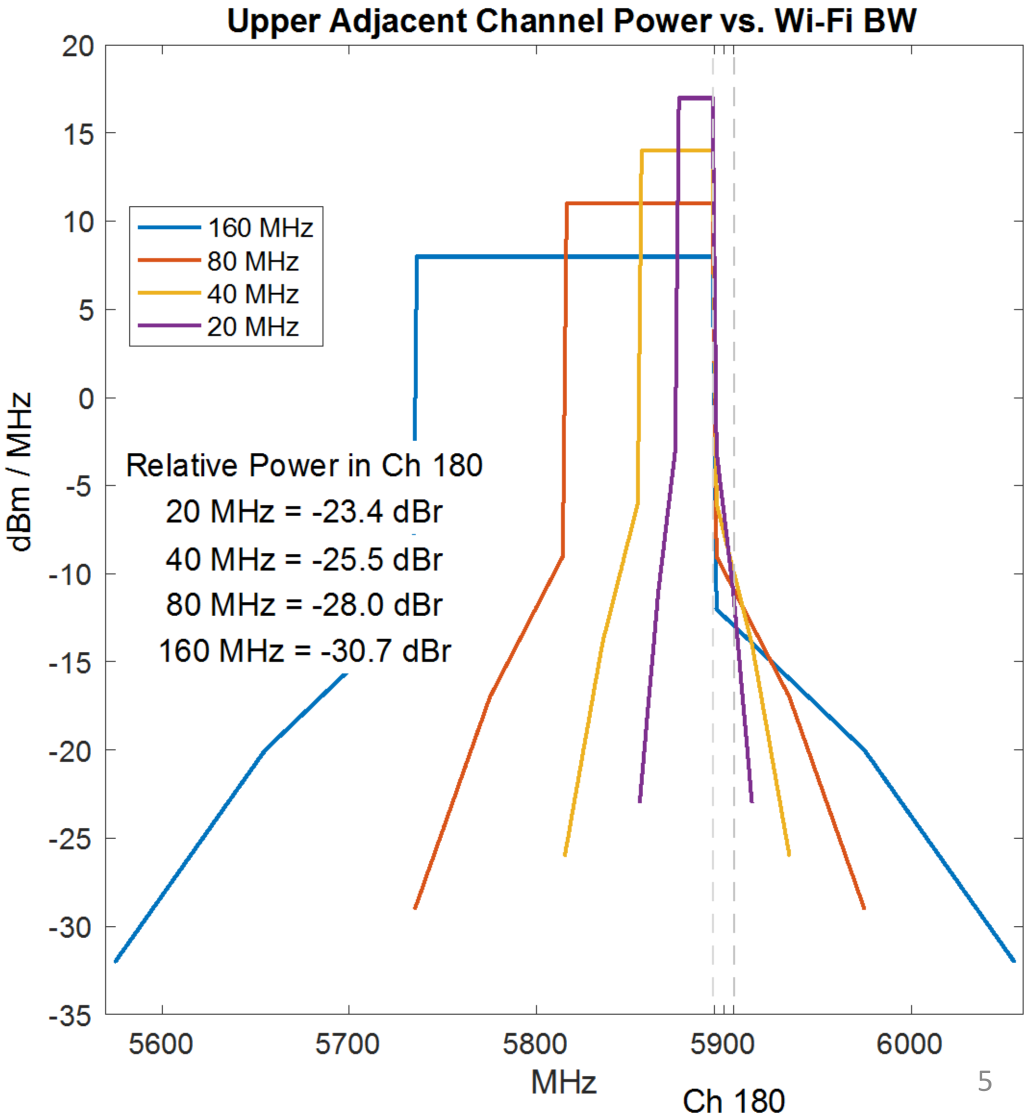
Conservative test parameters

- Taking a conservative approach, CableLabs examined multiple scenarios and tested interference potential in worst-case situations:
  - DSRC operating at its max range (very low signal level)
  - Wi-Fi traffic at various duty cycles, including fully saturated at ~100%
  - DSRC basic safety messages (BSMs) operating in the directly adjacent channel to Wi-Fi
- We also used a conservative threshold to measure impact on DSRC: PER of 10%.
  - Accordingly, our findings – which demonstrate reliable coexistence – likely overstate Wi-Fi's operational impact on DSRC.
  - In its DOT-commissioned research, Booz Allen testing used a 20% PER to characterize "error-free" DSRC.*

*Booz Allen Hamilton, *Dev. of DSRC Device & Commc'n Sys. Performance Measures: Recommendations for DSRC OBE Performance & Sec. Requirements*, Dep't of Transp. FHWA-JPO-17-483, at 52 (May 2016).

Most intense Wi-Fi power spectral density used in tests (20 MHz channelization)

- CableLabs conservatively tested coexistence with smallest Wi-Fi channels.
- Due to total power restriction reducing the power spectral density as Wi-Fi channels get wider, coexistence improves when 40, 80, or 160 MHz Wi-Fi channels are used.
- This plot uses Wi-Fi masks as defined by 802.11ac-2013; actual products typically perform better than the standard masks by varying margins, further enhancing coexistence.



*dBr in the plot is relative to in-band Wi-Fi power, 30 dBm as shown

Measurement method and results

Method:

- UNII-4-capable Wi-Fi and DSRC devices configured to ‘rechannelization’ scenario
- Tested a variety of DSRC and Wi-Fi received signal levels, Wi-Fi duty cycle levels, and spectral separations to determine the relative levels at which DSRC PER exceeds 10%
    - Tested DSRC at several received signal levels, from -88 dBm (the lowest level that DSRC was found to operate alone with < 10% PER) to -63 dBm
    - Tested varied Wi-Fi signal levels at the DSRC receiver to achieve 10% PER result
    - Tested different Wi-Fi duty cycles, including 10%, 30%, and ~100%
    - Spectral separation either zero or 10 MHz

Results:

- With DSRC @ -88 dBm and no spectral separation, PER exceeded 10% when Wi-Fi was:
    - @ -68 dBm at full duty cycle
    - @ -58 dBm at 30% duty cycle
    - @ -53 dBm at 10% duty cycle

Measurement results

- Testing demonstrated that inference from adjacent-channel Wi-Fi operations will not undermine DSRC safety services.
- Interference causing >10% PER was observed only when the power ratio between DSRC and Wi-Fi operating on a directly adjacent channel is **>100x.**
- That power ratio occurs only in very unlikely circumstances:
  - DSRC received signal strength must be extremely faint—at the edge of usability AND
  - Wi-Fi received signal strength must be uncommonly high—signal levels that are especially unlikely based on empirical measurement.
- As discussed below, these circumstances are likely to occur so infrequently that adjacent-channel Wi-Fi has, at most, only a 0.002% chance of causing a DSRC PER of 10% or greater.

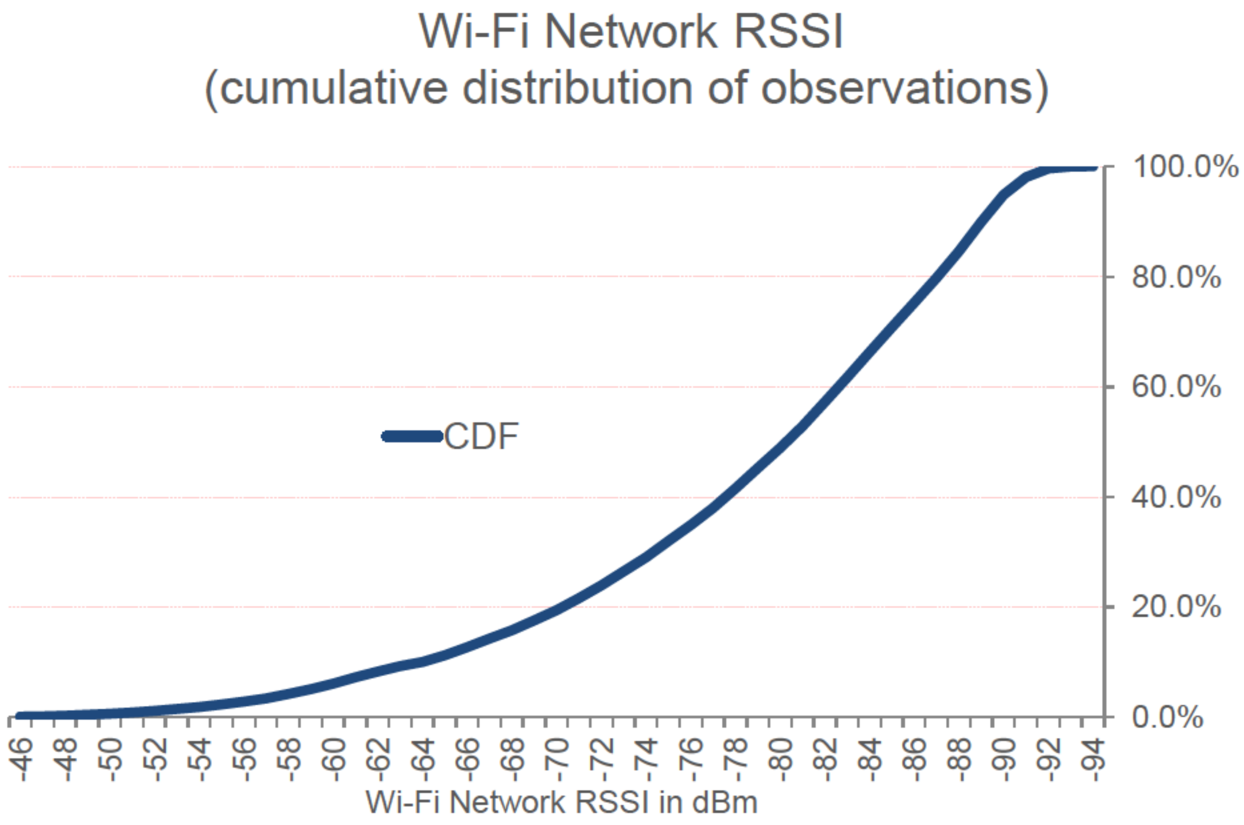
Risk-informed interference assessment

- Following the recommendation of the FCC TAC and leading scholars,* we anchored lab measurement results to real-world metrics to determine probabilities
- We calculated the probability of a situation occurring that produced 10% PER or higher, using relevant empirical data and industry-standard metrics, including:
    1. Real-world Wi-Fi signal level data
    2. DSRC signal level data from DoT pilot
    3. Wi-Fi duty cycles
    4. Wi-Fi channel availability

* *See, e.g.*, *A Quick Introduction to Risk-Informed Interference Assessment*, The Spectrum and Receiver Performance Working Group of the Federal Communications Commission Technological Advisory Council, April 15, 2015.

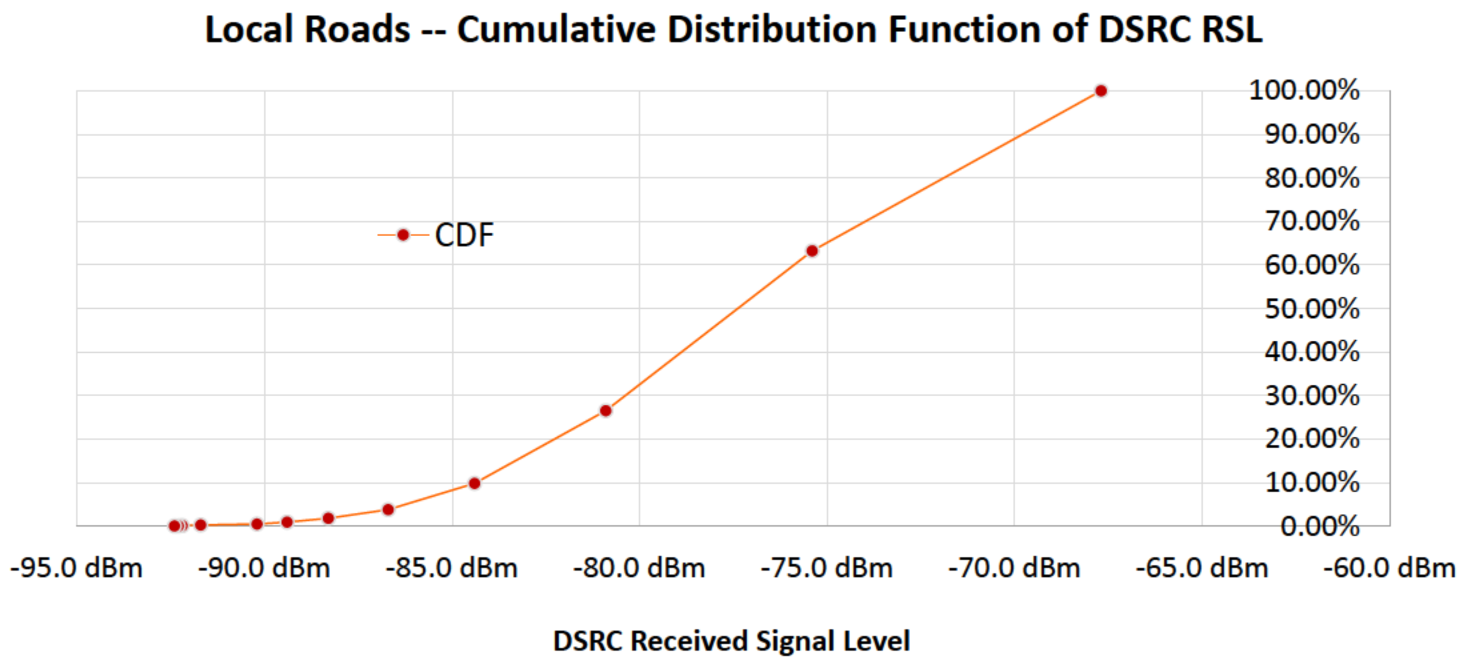
Wi-Fi signal levels

- To determine real-world Wi-Fi power levels, CableLabs used field measurements of RSSI from cable Wi-Fi access points.
- Field measurements taken from downlink client sessions, on outdoor 5 GHz access points owned and operated by cable operators.
- The resulting anonymized dataset contains 50,000 individual measurement samples taken from a period of multiple days.



DSRC signal levels

- DSRC signal level data is drawn from research published by NHTSA.*
- Using the V2V Safety Pilot's samples of received signal levels (RSL) taken in a variety of scenarios, researchers calculated the cumulative distribution function of DSRC RSL for the Deep Urban, Major Urban Thruway, Major Roads, and Local Roads scenarios.



* *Vehicle-to-Vehicle Safety System and Vehicle Build for Safety Pilot (V2V-SP), Final Report, Volume 2 of 2: Performance Testing* (April 10, 2014) (V2V Performance Testing Report).

Wi-Fi duty cycles and channels

Wi-Fi Duty Cycle:

- A 2015 study by Meraki* leveraged their cloud-based network management system to gather anonymized duty cycle information from approximately ten thousand radio access points, tens of thousands of links, and 5.6 million clients
- Both 2.4 GHz and 5 GHz traffic measured; 2.4 GHz duty cycle patterns were higher and we use those here to be conservative
- CDF generates real-world probability of measured Wi-Fi duty cycles:
  - 10% (or greater) duty cycle = 87%
  - 30% (or greater) duty cycle = 34%
  - ~100% duty cycle = 1%

Wi-Fi Channels:

- Impact to DSRC is also a function of the likelihood that Wi-Fi will operate on the channel immediately adjacent to DSRC (177)
  - Twelve 20 MHz channels would be widely used at 5 GHz under rechannelization (U-NII-1, 3, 4)
  - We used 12 channels for our analysis, though up to 30 could be accounted for in 5 GHz and 2.4 GHz, further reducing risk to DSRC

* Biswas et al, *Large Scale Measurement of Wireless Network Behavior,* Sigcomm 2015.

Risk-informed conclusion: extremely low probability of impact to adjacent DSRC operations

- Even in a local road scenario with low DSRC signal level (-88 dBm), high Wi-Fi signal level (-53 dBm), and moderate Wi-Fi duty cycle (10%) a packet error rate of 10% or greater was still very unlikely.

Probability of -88 dBm (or less) DSRC received power:	2.2% (on a local road)
Probability of -53 dBm (or more) Wi-Fi received power:	1.5%
Probability of Wi-Fi operating on adjacent channel 177:	8.3%
Probability of Wi-Fi operating at a duty cycle of 10% or more:	87%
Combined probability	**0.002%**

- Other variations across analytic dimensions (DSRC power, Wi-Fi power / duty cycles / channel availabilities, and spectral separation) yielded as good or better results

Adjacent-channel Wi-Fi operations do not pose safety concerns

- The bottom line: even under very conservative assumptions, the impact on DSRC from adjacent-channel Wi-Fi is less than what DOT has considered acceptable.
  - Moreover, the impact described above is the chance of an elevated packet-error rate—not harmful interference, a DSRC outage, or a failure to generate a warning to a driver.
- DOT has been willing tolerate risks to DSRC availability that are thousands of times more likely to occur.
  - Test Pilot data shows that the risk that DSRC will be unavailable due to GPS problems is thousands of times greater than the risk of interference from Wi-Fi.
  - Even a GPS receiver characterized as “best performing” resulted in DSRC being unavailable 2.01% of the time in deep urban scenarios and 1.28% of the time in local road scenarios.*
  - In those same scenarios, the risk of a DSRC PER greater than 10% as a result of Wi-Fi interference is just .0002% (deep urban) and .002% (local roads).

* *See* V2V Performance Testing Report at 14-15, 24 (numbers taken from performance of Receiver A1).

Thank you

For questions or additional information, please contact:

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